

Emotion regulation and spatial memory

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Author Note

This study was supported by UROP and Dr. Paul R. Schrater at University of Minnesota.

Abstract

The emotion and memory has been studied for a long time, but the emotion was mostly induced before their main memory task and the relationship between emotion regulation and spatial memory was rarely studied. We conducted one hour experiment with university students for last one semester and analyzed using Excel 2016 in the correlation between emotion regulation self-report measures and spatial memory task accuracy. DERS supported our hypothesis weakly but ACS didn't show the similar flow.

Keywords: emotion regulation, spatial memory, working memory, ACS, DERS

Emotion Regulation and Spatial Memory

1. Introduction**1.1. Definition of spatial memory and emotion regulation**

Spatial memory is the memory of information about one's surroundings. The spatial memory contains not only the information about one's environment, but it also the information about the orientation of objects. Emotion has an important impact on what is remembered and there are individual differences in how much people decide to express and capture own and others' emotions. This leads to important differences in how well the environment is remembered by the various people. By understanding the relationship between emotion regulation and spatial memory, we can better design instructional environments and help people to remember or to forget certain memories.

In part, spatial memory is a matter of habit and training (Carter, 2014, p.162). Woollett and Maguire (2011)'s London taxi driving experiment found people can improve their spatial memory through training. Gray et al. (2002) and Storbeck J. (2015) studied the influence of emotional state on verbal and spatial memory. They induced one of three types of emotions to each participant: pleasant, neutral, unpleasant. Storbeck J.'s results showed enhanced spatial memory in a pleasant state and impaired spatial memory in an unpleasant state. People tend to encode some emotion in any place, whenever they are in a room, at work, or at school. Spatially, arousal changes focus of the memory, impairing local memory (immediate surrounds) to favor global map-based memory (Brunye, Mahoney, Augustyn, & Taylor, 2009). The more strongly emotional events happen, the more change can occur in the encoding. For example, if one had a bullying experience at previous high school, he would still recall the unpleasant emotion at that time and related spatial components together when he visits the high school again even after some years. Some people might be

sensitive to emotion itself, at detecting and being influenced by, and others might not. This emotion sensitivity could help or hurt oneself in encoding the environment.

1.2. The current findings about the relationship

Previous research focused on how different emotional states at the time when testing the spatial memory task could affect the results. In other words, they induced certain emotions (induction stage) before spatial memory task (learning stage) and assessed the results of the spatial memory task (assessment stage). The current study is different from past studies in two distinctive ways: methodology, and perspective toward emotional components. In terms of method to test the relationship between emotion and spatial memory, the current study combines the induction and learning stage together as a stimulation phase. Also, the current study looks at emotion sensitivity and emotion control ability as inherited emotional components which the sensitivity on emotions refer to how fast people are at detecting self and others' emotions and the control ability refers to how well one can control – arousal to stable or other way around - and maintain their emotions.

Many previous studies showed emotional status affects spatial memory in enhancing or impairing based on whether one is sad or happy. Brunye et al. talked about the change in focus due to arousal change and Storbeck talked about the emotion's influence on the spatial memory. Emotion can affect memory in two ways, either increase or decrease, based on whether the object or environment itself has a high value or draws attention differently. Emotion can act to draw attention away from a task towards other thoughts and stimuli that would reduce task relevant encoding if one is emotionally neutral (Viviani, 2013). This suggests people with disorders entailing emotional instability could have difficulty in the encoding the environment and managing whether to remember the experience or not. In the current study, emotion sensitivity means how fast one can detect emotion of self and others, and emotion control ability is how well people can

manipulate their emotional state to neutral. My hypothesis in the current study is that the people who are sensitive to at least one of positive or negative emotion and are good at emotional control would have a good spatial memory.

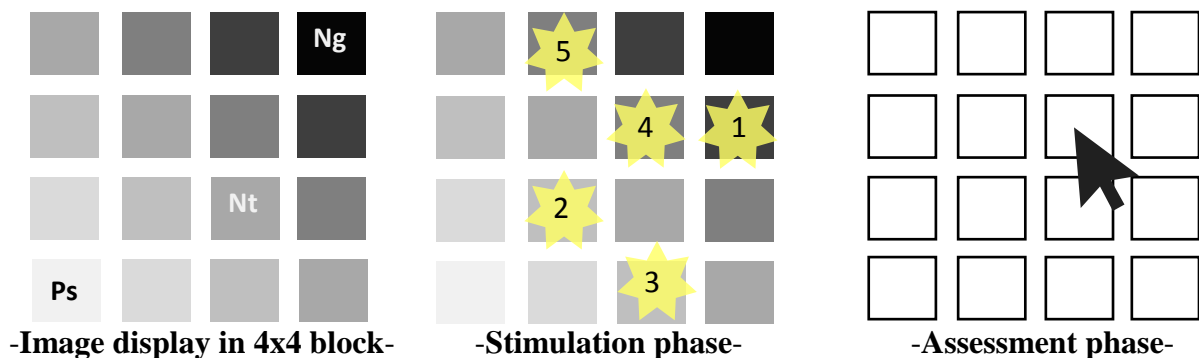
2. Method

2.1. Participants

24 of University of Minnesota students (mean age 20.38, SD 1.97) participated the study through the Research Experience Program (REP) system on the Department of Psychology website. Eighteen of them were females and six were males with normal or corrected vision. Twelve were Caucasians and twelve were Asians. The participants were compensated with either 2 REP points (with additional 1 REP point for traveling to the campus) for an extra credit in a class or \$10 per an hour of the visit. The surveys took about 3 to 10 minutes for each and the in-person experiment took 1 to 1.5 hours depending on the machine connections.

2.2. Design

The independent variable of current study was the individually different scores on the pre-experiment and the dependent variable was the accuracy in spatial memory task. The independent variable was manipulated as a between subject design. The initial conceptual design of spatial memory task is shown in the figure below.



The actual spatial memory task was conducted using 3 x 3 grid frame. The IAPS images were presented in each grid, in different combinations. The images with relatively more negative emotions were placed at the right bottom corner of the template and relatively positive images were presented at the other corner. There was gradual transition from highly negative images or highly positive images to the three neutral images placed on diagonal orientation in the middle. After an observation of the display, five out of 9 image blocks were bolded with red bolder at a time. One trial consists of observation, simulation, sequence test, question, and question test. The stimulation phase was to measure the spatial memory and the question phase was to let participants focus on details, for their attention. Participants had to answer where they saw the red bolder lines in grids in the order at the sequence test and where they saw the specific objects the question is asking at the question test. All the test screens were grey grid without any other images appearing. Participants were free to watch any part of the screen during the experiment, but they had to try to remember the sequence of the bolder appearance. The reaction time and accuracy of their spatial memory task were recorded.

2.3. Materials

All the data were collected using four computers, iMoion program, Electroencephalography (EEG) at the Multi-Sensory Perception (MSP) lab belongs to Center for Applied & Translational Sensory Science (CATSS), and self-reports created by Qualtrics. The two surveys measuring emotion regulations were duplicated ones of Affective Control Scale (ACS) and Difficulties in Emotion Regulation Scale (DERS). The ACS has 42 items and measures the ability in five big emotion categories: anger, depressed, anxiety, and positive. The DERS has 36 items and measure the difficulty in regulating of six big regulation associated concepts: non-acceptance, goal-directed behavior, awareness, strategies, and clarity. The full range of the pre-

rated pictures from the International Affective Picture System (IAPS) database were used as emotional stimuli. The IAPS database is composed of reliable images that elicit various emotions: positive, neutral, negative. Each image in IAPS is rated in terms of how much each feeling is elicited in 100 scale. The 64 electrode EEG was applied for additional biometric analysis. The samples can be found in appendix A. The image conglomerates were created based on random assignment to each grid location among images that has corresponding valence scores.

2.4. Procedure

Participants completed two online surveys before coming to the lab. The online surveys contained simple consent form, but they were informed with the full consent form with the experiment precautions at the beginning of the in-person experiment session. The two precautions we always mentioned were whether they are okay with using the electro-gel for the EEG measure and with watching explicit images. Participants sat in a soundproof room alone wearing the EEG cap during the experiment. They went through the practice first that contains 10 trials and finished main task that contains 50 trials.

3. Results

Data was collected and analyzed in iMotions (2016). The collected data were post processed and exported, saved as excel file. Data cleaning was done to clean the unnecessary data such as date of the experiment date. Using excel, the accuracy rates for sequence mouse click and question mouse click were calculated by each person. We classified answers as wrong when one of the five locations for a sequence test was wrong or when five mouse clicks combination was correct but has additional click or has a different order. Given the results of spatial memory task accuracy rate and emotion regulation questionnaires, we could draw the relationship between subjective regulating skill on emotion and spatial memory.

3.1. ACS

ACS scores for each emotional state were calculated individually using pre-programmed .pdf open source. The score for each item was converted to 1-7 (from “very strongly disagree” to “very strongly agree”) and added up together and divided into number of items for each emotional state: anger, depressed mood, anxiety, and positive affect. The mean for each emotion was similar to the original data result of Williams (1992)’s study but with a little bit higher means for our participant group. Mean score of anger was 3.64 (SD: 0.99, Min: 2.25, Max: 5.25), of depressed mood was 3.51 (SD: 1.14, Min: 1.25, Max: 5.50), of anxiety was 3.85 (SD: 0.76, Min: 2.77, Max: 5.54), of positive affect was 2.87 (SD: 0.71, Min: 1.71, Max: 4.79), and the total was 3.51 (SD: 0.67, Min: 2.52, Max: 5.12). Figure 2 shows the result for each participant with average dotted ring in the radar chart format and in the statistical chart format.

3.2. DERS

DERS scores for each emotional state were calculated using Excel 2016 functions. The score for each item was converted to 1-5 (from “almost never” to “almost always”) and added up together for each component measures: non-acceptance (Mean: 13.38, SD: 6.35, Min: 7.00, Max: 27.00), goals (Mean: 15.58, SD: 4.50, Min: 8.00, Max: 24.00), impulse (Mean: 11.13, SD: 4.92, Min: 6.00, Max: 24.00), awareness (Mean: 13.88, SD: 3.96, Min: 7.00, Max: 22.00), strategies (Mean: 16.83, SD: 6.88, Min: 9.00, Max: 33.00), and clarity (Mean: 10.88, SD: 3.21, Min: 6.00, Max: 18.00). Figure 3 shows the result for each participant with average dotted ring in the radar chart format and in the statistical chart format.

3.3. Spatial memory assessment and question assessment

In general, participants scored higher for the sequence assessment and lower for the question assessment. The mean accuracy rate for the sequence was 81.42% and the standard

deviation was 12.53% (Min: 54%, Max: 100%). The mean accuracy rate for the question was 55.33% and the standard deviation was 10.43% (Min: 38%, Max: 78%).

The correlation coefficient between sequence accuracy and question accuracy was 0.2. In the association between ACS and the assessments, there were two moderately negative relationships between score for anger (-0.4) and positive affect (-0.4) with the sequence accuracy and weak relationships between total score (-0.3) with the sequence accuracy and positive affect (0.3) with the question accuracy rate. The depressed mood and anxiety had no relationship with both accuracy rates. In the case of the DERS, only the impulse score had moderately negative relationship with the sequence accuracy (-0.5). The sequence accuracy rate had weak negative relationship with non-acceptance (-0.2), awareness (-0.2), strategy (-0.3), and total score (-0.3) and the question accuracy rate had weak positive relationship with goal (0.3) which had no association with sequence accuracy. The clarity component had very weak to no relationship with both accuracy rates. (See Table 1)

4. Discussion

We had two participants each with Attentional Deficit Disorder taking Adderall and Epilepsy history, both showed abnormal buzzing pattern on the EEG signal, but we didn't exclude them in the current results data since we didn't include biometric measure results here. The main idea was that people with high emotion control ability and emotion sensitivity in either positive or negative emotions are expected to have good spatial memory since they will be quick at encoding emotion in each space as much as they are fast at detecting each emotional component. In general, there were weak negative relationship between DERS scores and the sequence accuracy. Since the DERS is measuring the difficulties in cognitive components for regulating own emotions, the higher score means the more difficulty in each measure. So, in terms of the overall flow, this meets

with our hypothesis that those who are better at emotion regulation will be better at spatial memory. Also, the difficulty in regulating impulsivity had significant and moderately negative relationship to the sequence memory. This result is consistent with the previous research on people with disorders with impulsivity such as Attention deficit hyperactivity disorder (ADHD) in their impairment on the working memory (Schweizer et al., 2000; Englund et al., 2014). However, the ACS also had negative relationship with sequence accuracy which measures how much individuals are good at dealing with each emotional influence.

5. Limitation and future study

Current study aimed to measure emotion sensitivity from the length of staring on each image valence section (positive, negative, and neutral) and analyze the EEG activity at initial design but they were not analyzed under the lack of the ability and time. Also, iMotion program could record various biometric measures including Galvanic Skin Response, facial expression, and pupil size difference but we didn't include those measures in the current analysis. Even, the emotion regulation measure was subjective so The task screens were shown for short time relative to the amount of the given information, that participants were asked to focus on details of each image for 9 images at the same time, and this could have resulted in the mixed results. The current study employed a new style of task design to measure the relationship between emotion regulation and spatial memory, so it would be better to measure the relationship in the simplest version.

6. Acknowledgements

I thank Dr. Paul R. Schrater, Windy Torgerud, Ganesh Rakate, and Dominic Mussack at University of Minnesota for contributing the technical knowledge, idea on experiment development, and overall support. Also, thank Kai Xuan Nyoi, Jae Hyoung Bae, and Eunjeong Lee for contributing data collection and data cleaning. Finally, thank Multi-Sensory Perception

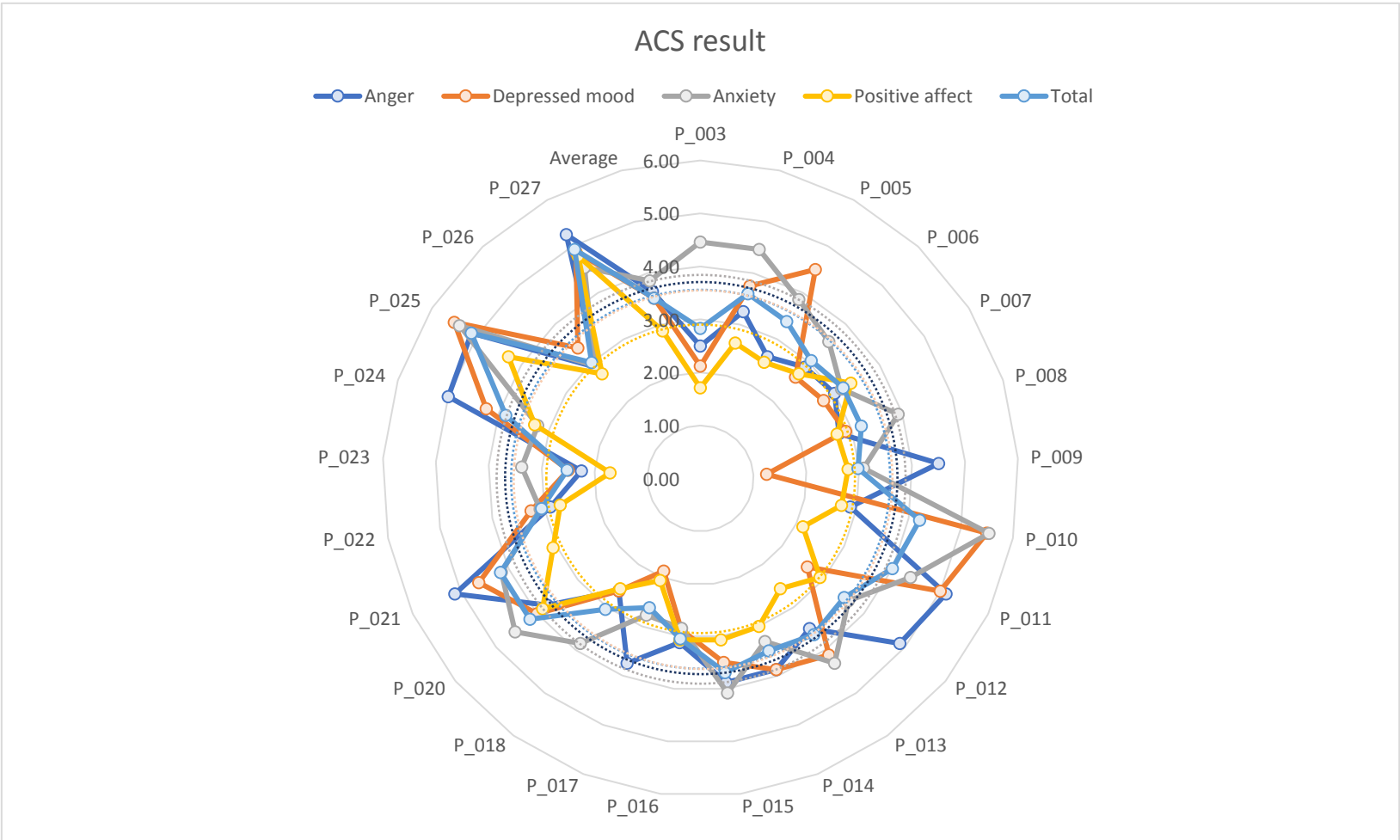
(MSP) Lab and Undergraduate Research Opportunity Program (UROP) at University of Minnesota for the space and opportunity for the experiment and the necessary funding.

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Figure 2

A. Result of ACS scores for each participant and average ring



B. ACS chart

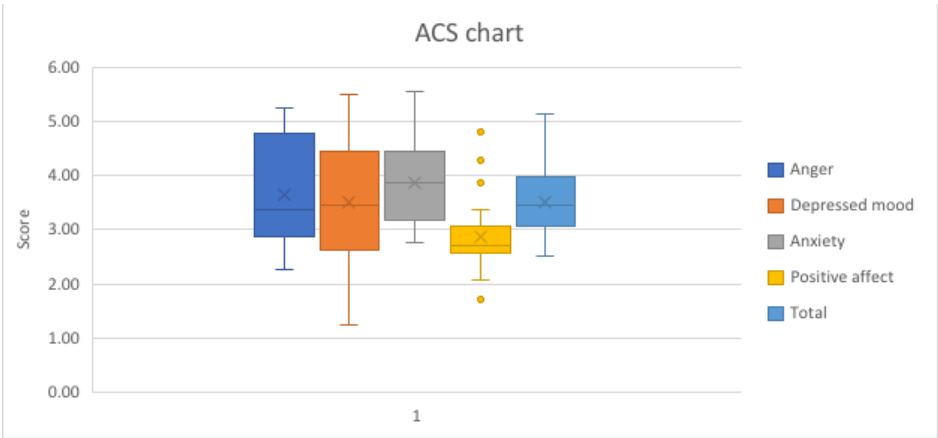
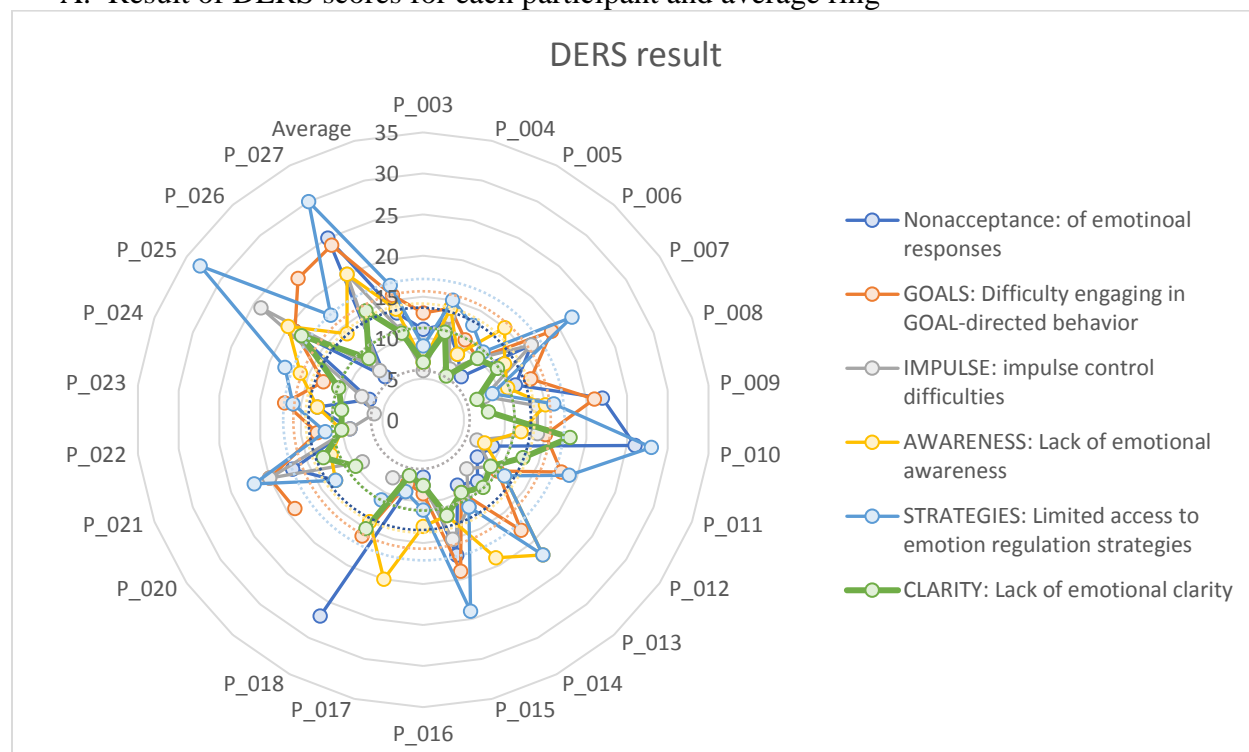


Figure 3

A. Result of DERS scores for each participant and average ring



B. DERS chart

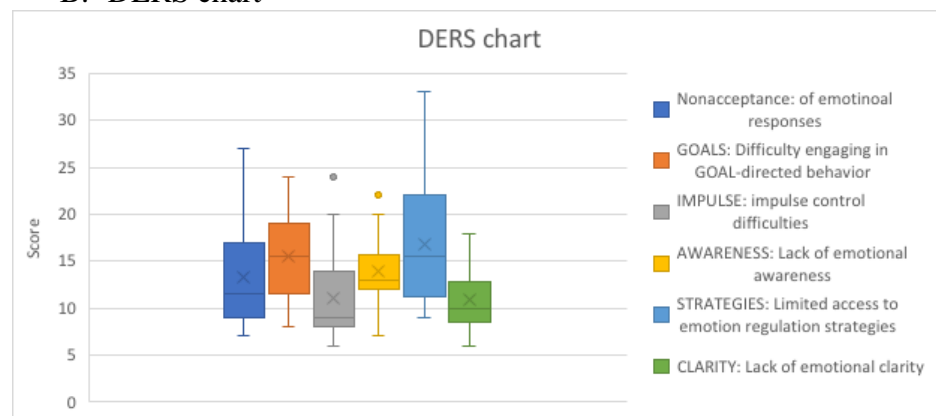


Table 1.

A. Correlation between ACE results and sequence, question results

	Sequence result	Question result
Anger	-0.405*	0.012
Depressed mood	-0.077	-0.146
Anxiety	-0.057	-0.002
Positive affect	-0.407*	0.031
Total	-0.304	-0.036

Note. Each subscale indicates how much one is good at regulating each mood. $r(22) = 0.---$, $p < (one\ tailed)$. * for significance at $p < 0.05$, ** for significance at $p < 0.02$ (two tailed).

B. Correlation between DERS results and sequence, question results

	Sequence result	Question result
Non-acceptance	-0.238	0.193
Goal	0.009	0.324
Impulse	-0.507**	-0.017
Awareness	-0.236	0.097
Strategy	-0.265	0.191
Clarity	-0.119	0.005
Total	-0.308	0.187

Note. Each subscale indicates difficulty or lack of the component related to emotion regulation. Non-acceptance: non-acceptance of emotional responses, Goals: difficulty engaging in goal-directed behavior, Impulse: impulse control difficulties, Awareness: lack of emotional awareness, Strategies: limited access to emotion regulation strategies, Clarity: lack of emotional clarity. * for significance at $p < 0.05$, ** for significance at $p < 0.02$ (two tailed).

Appendix A
Sample screens of the experiment

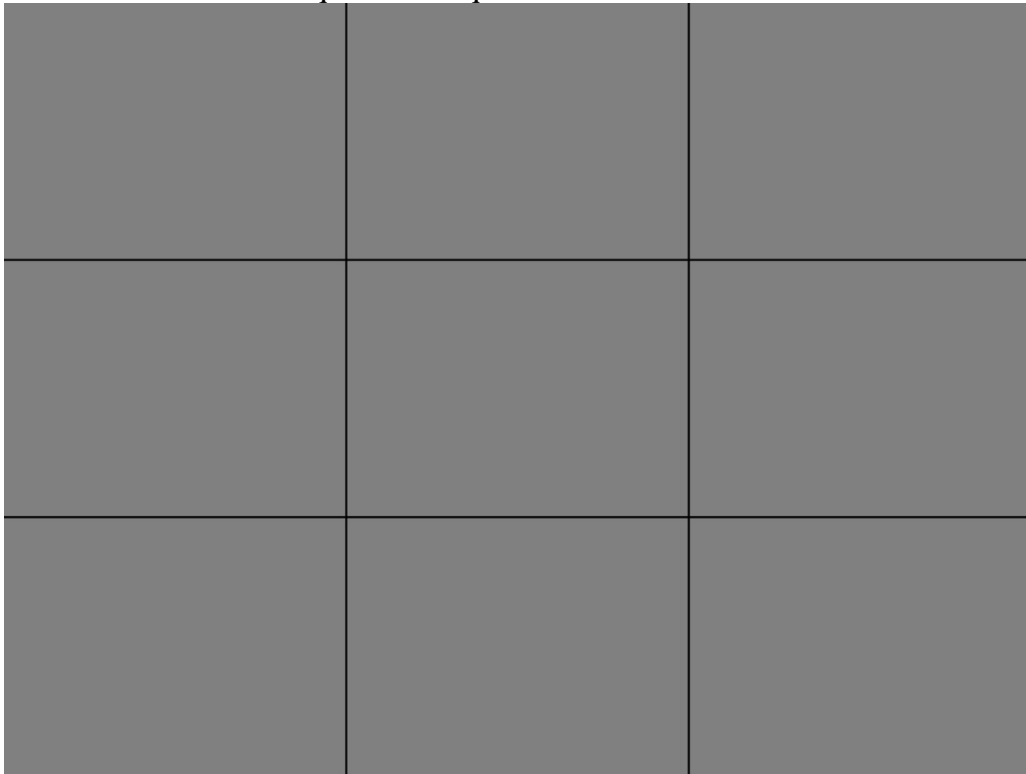
1. Observation (10 sec)



2. Five red bolder appearing (each for 1 sec)



3. Assessment screen for both sequence and question answers



4. Question screen

